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The U.S.S. Saratoga takes her first trip

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SPECIAL FEATURES

DEPARTMENTS

THE LAUNCHING OF THE SARATOGA

STABILITY AND CONTROLLABILITY OF AIRPLANES

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The Saratoga

No more impressive sight has ever been given to aeronautical observers than the launching of the majestic aircraft carrier U. S. S. Saratoga. This latest product of naval architectural genius is not only the last word in ships but in its experimental features it will be a veritable floating aeronautical laboratory. Entirely apart from its relationship to warfare the Saratoga is exceptional in its superlative characteristics. It has the greatest power of any ship; it has double the horsepower of the Leviathan. It is the longest ship. When launched it was more nearly completed than is usual with naval vessels, so that it was the greatest weight that ever slipped down the ways. Its commissioned personnel will exceed that of any battleship, one hundred and eighty officers being required. Its sixteen hundred enlisted men will represent a variety of trades an expert crew such as was never before known afloat. With its sister ship, the Lexington it will be the largest and fastest craft of its kind in the world.

It is interesting to recall at this time that it is due to the money subscribed by Japanese children that these carriers were allowed to the United States. At the time of the Limitation of Arms Conference, the British had three aircraft carriers, the French had an experimental ship and the Langley was building. The Japanese had none, but they had an armored cruiser that had been built partly by the pennies contributed by school children. It was claimed by Japan's representatives that the scrapping of this ship was inadvisable owing to popular national sentiment, but that it could be made into an aircraft carrier, although the limitation on aircraft carriers under the treaty had been fixed at 27,000 tons. The best that could be done with this 45,000 ton ship in the converting process was a minimum of 33,000 tons. As the dimensions of the Japanese ship were about the same as our battle cruisers that were to be scrapped, our Naval officers stated that the same change could be made with our ships. It was agreed by all the parties to the treaty that the conversion would be allowed and in this way the United States came to complete the two cruisers as aircraft carriers. It is one of those little bits of sentimental history that may have a marked effect on future naval warfare.

The cost of the Saratoga was originally intended to be $23,000,000 but by additional improvements this has been increased to about $45,000,000. This appears to be a large amount of money to put into an experimental ship, particularly as there is no firm conviction among naval experts even as to what the future type of aircraft carrier will be. There appear to be two distinct views; one which favors the large floating ship, the other believing that three ten thousand ton ships would have very decided advantages over the larger carrier. The cost of the three smaller ships would be about the same as the 33,000 ton Saratoga. The larger ship would have the advantage of speed, ability to maintain speed in heavy seas, a stable platform, and to carry a large number of airplanes. The smaller ships would be able to fly their aircraft off the decks three times as fast as the larger carrier, and also to receive them back on board three times as fast. They would be three times less vulnerable to attack, and when lost, the deficiency in the fleet's air power would not be so great. While the flying platform is less stable it is thought that the smaller carrier will give a percentage of flying availability that would be satisfactory, for there is a question as to the efficiency of any carrier operating in heavy seas.

Three small carriers could cover much more sea area than one large ship. The smaller ships could carry more airplanes than the larger carriers. It will be noted from these differences which are naval opinions and not ours that there is much variance of thought in this new field of naval construction. One thing that can be regarded as certain, and that is that no effort will be neglected by the Naval authorities to increase the air power of the fleet, they having come to a very real realization of the necessities of aviation as a prime requirement of any navy.

Anti Aircraft

THE ridicule that has been heaped on anti-aircraft guns by the flying fraternity is bound to have an unfortunate reaction. While it is agreed that anti aircraft guns make almost an infinitesimal percentage of hits when firing at a target in the air, the danger of the barrage is to be given more deferential consideration. One of our Air Service officers who has had much experience in towing targets for anti-aircraft guns made a very apt remark when he said that the danger from anti-aircraft fire was mainly from aircraft running into the fire rather than from direct hits. That an anti-aircraft barrage can be very dangerous to attacking airplanes flying under ten to fifteen thousand feet must be anticipated as a real problem. Underestimating the strength of an opponent is always unwise.

Then it seems to us that air forces should develop anti-aircraft defenses. Aircraft is the best defense against aircraft—but all the auxiliaries should be under one command. Division of command in defense is fatal—as would be evident by the division of functions of aerial coast defense between the Army and Navy. The Coast Defense of any country will eventually come under air forces—with guns as adjuncts.

The Aircraft Carrier Saratoga Launched

Largest and Fastest Ship of its Kind to be Ready Next Year

The U S S. Saratoga, built to carry seventy-two planes for the Navy with the most powerful engines ever put into a vessel, was launched at the New York Shipbuilding Corp. shipyard at Camden, N. J., at 1:17 p. m. on April 7. The ship's dynamos and steam turbines were constructed for extraordinary speed and would carry her across the Atlantic in less than four days. The ship is 888 ft. long, making her the longest naval craft in the world. The flying deck which covers her is long and wide enough to hold two oldtime battleships set end to end.

As the vessel started down the ways Mrs. Curtis D. Wilbur, wife of the Secretary of the Navy, swung a bottle of mineral water, decorated with red, white and blue ribbons, against the bow, and said:

"I christen thee Saratoga."

Every precaution was taken to prevent the ship racing across the Delaware River and into the Philadelphia piers after the launching. A heavy cable was attached to buoys a short distance from the New Jersey shore and the vessel was halted as it struck this. Anchors were thrown over immediately and tugs worked the ship into a safe position.

Twenty airplanes flew over the shipyards as the Saratoga was christened. Just after she slid out on the water twenty carrier pigeons were released by Mrs. Wilbur with a message to President Coolidge announcing that the ship had been launched. The birds flew to their home at the Naval Air Station in Washington and the message was delivered to the President just after 4 o'clock. It read:

"The U.S.S. Saratoga, aircraft carrier, has been christened and launched at the New York Shipbuilding Company's yard at Camden, N. J., contemporaneously with the release of this message by carrier pigeon.

"CURTISS D. WILBUR."

In Secretary Wilbur's speech after the launching he emphasized the Saratoga's relation to the Naval Arms Conference at Washington and the Arms Limitation Agreement.

"The launching of the Saratoga is an event of great significance. It has a historical significance. It is the fifth ship of that name in the United States Navy. The fourth Saratoga, an armored cruiser, was launched in Philadelphia in 1891, originally known as the New York. It was Admiral Sampson's flag ship at Santiago in the war by which the liberty of Cuba, of Porto Rico and of the Philippines was achieved. The New York, afterwards the Saratoga, is now the Rochester, the flag ship of our Special Service Squadron, although thirty-three years old. Her commander, Captain Ellis, reports that the ship is in fine shape and as good as the day she was commissioned. This fact is worthy of note in view of the fact that the warship is considered to have a life of only twenty years. What is meant by the statement that the life of the battleship or capital ship is only twenty years is that by reason of new developments constantly being made the twenty year old battleship would be comparatively helpless in a battle with a new ship with all the improvements and additions developed in the twenty years after the older ship was built. In contrast with this when we say that the life of an airplane is three years we mean that on the average a plane is non existent after a lapse of three years.

"We come now the the new "Saratoga" that has just been launched at the yards of the New York Shipbuilding Corp. This ship was authorized by Congress in 1916. It was to be a battle cruiser carrying eight 16-in. and sixteen 6-in. and four 3-in. anti-aircraft guns. The contract for the ship was let before we entered into the World War, but the keel was not laid until 1920 because the unrestricted submarine warfare made it imperative that we should devote all our ship building energy to the production of destroyers, submarines and merchant ships. After the close of the World War we began the construction of the vessels authorized by the building program of 1916, which had not yet been started, and resumed construction upon those which had been begun. In the midst of this tremendous building activity upon these great ships, the Conference for the Limitation of Naval Armament was called by President Harding.

"It was agreed by signatory powers that their respective naval establishments should be limited in accordance with the Treaty then entered into. In pursuance of this agreement, eighty capital ships, twenty-eight of which belonged to this nation, were scrapped. Of our new ships, then building, the Colorado and West Virginia were completed and the Saratoga and Lexington, originally laid down as battle cruisers, were, in accordance with the agreement, to be converted to aircraft carriers. This ship, in her present condition, is not only a concrete evidence of the effect of the agreement limiting naval armament, but is also concrete evidence of the fact that at that conference the question of aircraft was under consideration and that one of the methods adopted for limiting the effect of aircraft in transoceanic warfare was by limiting the size and number of aircraft carriers. Under the terms of that agreement we were authorized to complete the Lexington and Saratoga as aircraft carriers, each to have a displacement of 33,000 tons, and in addition to complete aircraft carriers having a total tonnage of 69,000 tons, making the total displacement of aircraft carriers of over 10,000 tons each, 135,000 tons. The Saratoga with her 33,000 tons, will carry 72 planes, of which 31 will be bombing planes, that is to say, for each bombing plane carried there will be about 1,000 tons of weight to the ship.

"The total cost of the Saratoga with all her equipment will be about $45,000,000. Thus for each bombing plane carried she will have to have more than one thousand tons of displacement costing over a million dollars. As an illustration of how these facts may be overlooked or ignored, it may be stated that in a recent examination of a retired Naval officer before a Congressional Committee he was asked "Would you rather have a forty-five million dollar battleship or a thousand bombing planes?" The questioner undoubtedly assumed that the two were equivalent, namely, that a bombing plane cost $45,000 and that you could build a thousand of them for the cost of a battleship, but the admiral under examination may have made a mental calculation something like this. 'It takes a thousand tons of an aircraft carrier costing a thousand dollars a ton to carry one bombing plane; to carry a thousand bombing planes would require a million tons of shipping. This would be almost equal to the combined tonnage of Great Britain and America in capital ships under the Treaty for the Limitation of Armaments. It would require in addition to the 35,000 aircraft tonnage authorized by the Treaty eighty six aircraft carriers of 10,000 each. Thus, to take care of 1,000 bombing planes we would have to add ninety-one aircraft carriers to the Navy, each ship to have her auxiliary fighting and spotting planes. Moreover, the shore establishment of the Navy is about equal in value to all the vessels in the Navy, that is, about a billion and a half dollars, the addition of ninety aircraft carriers to the Fleet would require substantial addition to the shore facilities, probably not equal in value to the cost of all of the carriers, that is a billion dollars, but at least a substantial addition to the present shore facilities.' To man these ninety-one ships would also require that the personnel of the Navy to be about doubled and the annual appropriations increased by about one hundred million dollars. After this hasty mental approximation of the result involved in the addition of 1,000 bombing planes to the Navy, the witness, who believed in both a surface navy and in the expansion of the naval aircraft program, answered that he would prefer the 1,000 bombing planes. Of course I do not pretend to say that I have correctly portrayed the mental operations of this witness, but the suggestion illustrates the implication involved in a substantial addition to the naval air force.

"In this connection it should be observed also that in the proposition advanced before the last Congress for the unification of the air force, it was provided that all aircraft carriers should be turned over to the new department. Thus this great ship, the Saratoga, designed and built under the supervision of the Engineering and Construction Corps of the Navy was to be turned over to this new organization, because, although our Naval officers were sufficiently progressive to design, conceive, construct and put in commission the new ship, it was believed by the proponents of the measure that they were not sufficiently progressive to operate the ships.

"To propel the Saratoga at her designed speed of 33.9 knots (almost 39 mi./hr.), 180,000 hp. must be applied to the four shafts. Steam to produce this power will be generated in 8 Yarrow boilers, each with a horsepower of 11,250. Steam is produced at a pressure of 295 lb./sq. in. At full power, the boilers will burn 600 barrels of fuel oil per hour, or 2,000 tons per day. Her oil capacity will enable her to cross the Atlantic at top speed in less than four days. The steam produced will drive four turbo alternators, each of which is rated at 40,000 kva., 5,000 volts, 1755 r.p.m., 3-phase, 4-pole. If the Saratoga could be tied up to a dock in Boston, and its generators connected to the power house, these four turbo alternators would furnish power and light for all electrical activities of that great city. It wouldn't take care of Philadelphia. This city's load is too big.

"The power generated by the alternators is supplied to eight giant motors, two on each of the four shafts. Each of these motors puts 22,500, hp. into the shafts which turn the propellers 317 times per minute. If horses could be used to pull this great Man-o'-War at its designed speed, we would need 180,000 which could keep up their phenomenal race-track speed hour after hour and pull a horsepower all the time.

"In addition to the main propelling equipment of the vessel, there will be six 750 kw turbo generators which will furnish electricity for excitation of the main generators for lighting the vessel and for the many varied power activities. There are over 6,000 lamps on the vessel, which vary from the ⅛ candlepower small instrument lamps up to the 3,260,000 candlepower of the 36-in. searchlights. Over a thousand motors are installed, which vary in size from the 425 hp., motor driven fans, which supply air to the wind tunnel, down to the tiny motors in the fire control system which develop less than 1/2000 hp.

"All of the mighty power of this vessel is confined in a space which a central station man ashore would deem impracticable. For instance, the space taken up by the Hartford central power stations, among the most efficient in the country, is eleven times as great per horsepower as that on the Saratoga. All this mighty power is responsive to the Commander-in-Chief whose orders may be delivered across continents and oceans by ether waves invisible and inaudible to human beings until received and transformed by the delicate radio apparatus. This mighty machine may be thus directed by waves started by the electrons split from the infinitesimal atom.

"The mortal mind has conceived and put into execution nothing which embodies more of the accumulation of human knowledge than the vessel being launched today."

The address of Secretary Wilbur was followed by talks by Rear Admr. William A. Moffett, Chief of the Bureau of Aeronautics, Capt. Walter R. Gherardi, Aide to the Secretary of the Navy and formerly commander of the Aircraft Squadrons Scouting Fleet, and Comdr. Kenneth Whiting, formerly executive officer of the Langley.

Parts of Admiral Moffett's address follow:

'The early history of naval aviation is linked up with the early development of aviation in America. Naval officers were among the first to appreciate the importance of aircraft in naval warfare. The advent of the airplane injected a new problem into the strategy and tactics of the sea.

"Early in 1911 the first aviation unit was formed in the Navy. It consisted of a few naval officers who volunteered for the duty and who were assigned to courses of instruction under the Wright brothers and Glenn Curtiss. The machines which they were taught to fly would today be considered veritable death traps, and their value for military purposes would be absolutely nil. But from this beginning grew a service which during the war gave an excellent account of itself, and since the war has been expanded and developed into a vital part of the Navy.

"When the United States entered the Great War there were 38 qualified officer pilots in the Navy and 163 enlisted men serving with aviation units. When the armistice was signed this force had been expanded to nearly 7,000 officers, qualified or under training, and over 30,000 enlisted men.

"The principal activities of naval aviation during the war were carried on from shore bases, because of the nature of the naval operations. The submarine menace was the major problem confronting naval authorities, and naval aircraft were principally concerned with searching out and attacking the undersea boats. Naval air bases were established in England, France and Italy, the most active being located at Dunkirk in France and Killingholme in England. How well these units did their work is attested by the fact that not a single convoy escorted by aircraft was successfully attacked by submarines on the western shores of France after the naval air stations were established by the Americans abroad.

"Since the war naval aviation has been developed along lines to make it a service to the fleet at sea. Operations from shore bases met the exigencies of the situation as regards anti-submarine warfare, but naval aviation must be an integral part of the naval forces in order to best serve them.

"Airplanes for ships and ships for airplanes expresses the naval air problem, and its solution is represented in the development of the past four years.

"The aircraft carriers give ships to the planes. The carrier for naval aircraft is a new type of naval vessel which is designed to carry large numbers of every type of naval plane. Scouts, bombers, torpedo planes, and combat planes are all included in the aircraft to be found on the carrier, for it is a mobile air base which travels with the fleet and carries the air force essential to the operations of the surface ships.

"We are prone to think too much about national defense and forget national offense. It is the Navy's mission to protect our seaborne commerce and far flung possessions. We must take the offensive to win a war. The Navy is the first line of offense and Naval aviation as the advance guard of this first line must bear the first brunt of attack. Naval aviation cannot be effective from the shore. It must go to sea on the backs of the fleet. All the aircraft in the world based on shore can not ward off a bombing attack launched from enemy carriers by night from an unknown point and destined for an unknown objective, but our fleet, with adequate aviation of its own, can drive the carriers out of effective range. Both for offense and defense the fleet and naval aviation are one and inseparable.

"The very isolation that gives us defensive strength gives us offensive weakness and complicates the Navy's problem. No one appreciates the complications of naval aviation like those of us who fly over the sea. We could have no finer illustration of the difficulties of naval aviation than the World Cruise. The outstanding feature of this flight was the triumph of individual courage and far sighted preparation over the inherent limitations of aircraft as vehicles over the sea. The unmistakable lesson of this flight, and one we must not forget, is the utter and absolute dependence of aircraft over the sea upon surface craft.

"Now the problem of sending aviation to sea with the fleet is a difficult one. It takes a seaman to go to sea. Your naval aviator must be both a seaman and an airman, and this is a man-sized job. The fleet must be ready to fight an action by day or night in any kind of weather, and we have a job on our hands to bring aviation up to the needs of the fleet. Aviation has conquered the air but not the sea."

Parachute Saves Another

The planes of two Marine Corps aviators were in collision 1,000 ft. above the Quantico, Va., field April 6, but the pilots escaped injury. Gunnery Sergt. L. E. Mix, the tail of whose plane was severed, leaped 700 ft. with a parachute into a tree top. Gunnery Sergt. Archie Paschal righted his machine when it was within 300 ft. of the ground and effected a landing despite the loss of half a wing. The planes were maneuvering in a group of five when the wing of Paschal's machine struck the tail of that piloted by Mix.

Stability and Controllability of Airplanes

Appendix II. Balance Calculation Concluded

By B. V. KORVIN-KROUKOVSKY

The tail plane is located largely in the slipstream of the propeller and its lift (up or down) at any angle of incidence δ is increased in the ratio $(V_s/V)^2$, where V_s is the velocity of air in the slipstream. Ordinarily in modern machines the stabilizer has a span of from 1.2 to 1.5 of the propeller diameter. However, the lift of the type of any airfoil is comparatively small and the error introduced by assuming the whole of the empennage to be in the slipstream is probably negligible.

The consideration given above allows us to write the following expression for the pitching moment due to the tail plane:

$$M_s = fL = qsC'_l\, L\, \left(\frac{V_s}{V}\right)^2$$

or, substituting $C'_l = \delta n'$ and dividing by qSl

$$[9] \qquad M_{sc} = \delta\, \frac{sL}{Sl}\, n'\, \left(\frac{V_s}{V}\right)^2$$

We will denote the ratio sL/Sl by B_s. The quantity $B_s n'$ represents the pitching moment coefficient due to the tail plane per one degree of its angle of incidence. The importance of this quantity in stability and balance calculations is second only to the position of the center of gravity.

The slipstream ratio V_s/V can be very closely approximated by the empirical formulas:

$$[10] \qquad \frac{V_s}{V} = \frac{k_s}{V} + 1 \qquad \text{or} \qquad \frac{V_s}{V} = k_s \frac{S}{W} C_l + 1$$

where the coefficients k_s and k_s constant for any given engine-propeller combination, are found to depend on the rated horsepower and r.p.m. of the engine as follows:

$$k_s = 0.01\, P^{0.5}\, (rpm)^{1.3}$$
$$k_s = 0.0000255\, P^{0.5}\, (rpm)^{1.1}$$

The values of these coefficients for several well known engines are given in the Table II.

Final Equation

Now we have expanded all terms in the equation of equilibrium [1] and are ready to write the final equation. Substituting expressions [5], [8], [9] and [10] into [1], solving for the angle δ and rearranging the terms in the powers of C_l we obtain

$$[11] \qquad \delta = \frac{D\, C_l^2 + E\, C_l + G\, C_l^{1.1} - C_{mo} - H}{B_s n' \,(Q\, C_l + 1)^2}$$

where the balance coefficients D, E, G and Q have the following values, constant for any given airplane.

$$[12] \qquad D = -\frac{y}{l}\,\frac{1}{57.3\, n}$$

$$E = \frac{x_o}{l} + \frac{y}{l}\,\frac{C_{lo}}{57.3\, n} - 0.25 - \frac{y'}{l}\,\frac{P}{W} k_s$$

$$G = \frac{y'}{l}\,\frac{P}{W}\, k_s \sqrt{\frac{}{S}}$$

$$Q = k_s \frac{}{W}$$

The coefficient H is a purely empirical correction factor obtained by the trial application of the method described here to several existing airplanes, as well as to wind tunnel models and by comparing the calculated results with the flight test data. When such a comparison was made without introduction of any correction factor it was found that the computations were in fair agreement with the model test data, but both differed from the flying tests by indicating excessive tail heaviness. No explanation could be found of this lack of agreement, but its consistent presence in cases of all analyzed machines allowed the introduction of the empirical correction factor dependent on the weight of the machine.

$$H = 0.00125\, \sqrt{W}$$

The machines used in the computations ranged from the weight of 1400 lb. to 5100 lb., and the validity of the coefficient H for heavier machines may be questioned until checked on some existing heavy machines. For the machines lighter than 1400 lb. this question is not important as the possible error in H will never result in error of more than one degree in the stabilizer setting, which will be hardly noticeable in view of the light control forces of these machines.

Wing Incidence

We have completed now the first part of the job; the determination of the angle of incidence of the tail plane δ. It now remains to determine the angle of incidence of the wings α corresponding to any given value of the lift coefficient C_l, and the angle of downwash ε. The designer of an airplane usually has in his possession the characteristic curve of the airfoil he expects to use, obtained by wind tunnel test on the model of the aspect ratio of 6. If his wing combination has a different value of the effective aspect ratio, being for instance a biplane similar to the Vought VE7 with $R = 4.7$, the use of the standard airfoil test data may involve the error of some 3 deg. in the angle of incidence at low speed, with corresponding error in the angle of stabilizer setting. To avoid this error without undue complications we recommend the following method of procedure, based on our fundamental assumption that the slope of the lift coefficient curve n depends only on the effective aspect ratio. Take the angle of attack α_o as shown on the balance diagram and find the corresponding value of the lift coefficient C_{lo} from the characteristic curves for the standard airfoil. Calculate the angle of incidence corresponding to any other value of C_l by the formula

$$[13] \qquad \alpha = \alpha_o + \frac{C_l - C_{lo}}{a}$$

The angle of attack α_o rarely exceeds 3 deg. and the value of the lift coefficient C_{lo} corresponding to it will be very little affected by the difference in plan form and arrangement of the two wings. As the angle α_o and the lift coefficient C_{lo} were already used elsewhere in this paper, they form a very convenient starting point for the calculation of the angles of incidence corresponding to all values of the lift coefficient.

Downwash

For determination of the angle of downwash we will use the same formula (Lieutenant Diehl's) as was used in the previous paper:

$$[14] \qquad \varepsilon = \frac{85}{R}\, (x+1)^{-0.38}\, (y+1)^{-0.37}$$

where x and y are the ordinates of the leading edge of the tail plane with respect to the trailing edge of the wing expressed in terms of the mean wing chord. These ordinates are measured parallel and perpendicular to the line of flight *when the machine is pitched at the angle of zero lift on the wings*, and do not change with the angle of incidence. In order to avoid the use of additional dimensions of the machine than those required for the use of our method, we will note that distance from the trailing edge of the wing to the leading edge of the stabilizer plan one chord length is practically equal to the distance from the center of gravity of the machine to the center of pressure on the tail, that is: $x + 1$ in Lieutenant Diehl's notation $= L/l$ in our notation.

The effect of $(y+1)^{-0.37}$ in ordinary cases is very small and can be neglected. This term will have to be considered, however, in the case of the tail plane being located very far above the mean wing chord, as for instance in the case of a low wing monoplane with high lift wings set at large angles of incidence and with the stabilizer placed on the upper longerons of the fuselage. We can now rewrite the formula [14] in a simplified way for use in ordinary cases as follows:

$$[15] \qquad \varepsilon = \frac{85}{R}\, K\, C_l$$

where the coefficient $K = (L/l)^{-0.38}$. For the convenience of the designer the values of K corresponding to several values of ratio L/l are tabulated below.

TABLE III

Ratio L/l	Value of K
2.5	0.71
2.6	0.70
2.7	0.69
2.8	0.68
2.9	0.67
3.0	0.66
3.1	0.65
3.2	0.64
3.3	0.63
3.4	0.63
3.5	0.62

In the case of a pusher machine, the direction of the downwash is somewhat modified by the slipstream of the propeller. It is reasonable to assume that the final direction of the air velocity back of the wings and pusher propeller can be found by adding geometrically the vectors of the downwash of the wings as determined by the formula [15] and the added velocity of the slipstream, assumed to be parallel to the thrust line. We can perform this operation by resolving each of the vectors into components parallel and perpendicular to the line of flight, adding the vertical and horizontal components separately and taking the ratio of the sums. We will remember that we denoted by α_o the angle between the thrust line and the chord of the wing, and that $\alpha - \alpha_o$ represents the angle between the thrust line and the flight path at any angle of incidence α of the wings. Denoting by ε' the angle of resultant downwash of the pusher machine and by V' the added velocity of the slipstream $V' = V_s - V$ we can write:

$$[16] \qquad \tan \varepsilon' = \frac{V' \sin (\alpha - \alpha_o) + V \sin \varepsilon}{V' \cos (\alpha - \alpha_o) + V \cos \varepsilon}$$

where the numerator represents the sum of the vertical components and the denominator, the sum of the horizontal components of the two velocity vectors. As neither α nor ε ever exceed 10 deg. in normal flight, we can simplify expression [16] by letting $\cos(\alpha - \alpha_o) = \cos \varepsilon = 1$, $\sin(\alpha - \alpha_o) = \alpha - \alpha_o$ and $\sin \varepsilon = \varepsilon$. Furthermore, it will be more convenient in the practical application of the method to calculate the correction of the angle of downwash $\Delta\varepsilon = \varepsilon' - \varepsilon$ rather than the angle ε' itself. We will remember also that $V'/V = QC_l$. Then we can rewrite the expression [16] as follows:

$$\Delta\varepsilon = \frac{\frac{V'}{V}(\alpha - \alpha_o) + \varepsilon}{\frac{V'}{V} + 1} - \varepsilon =$$

$$\frac{Q\, C_l\, (\alpha - \alpha_o) + \varepsilon - (Q\, C_l + 1)\, \varepsilon}{Q\, C_l + 1}$$

or finally

$$[17] \qquad \Delta\varepsilon = \frac{Q\, C_l\, (\alpha - \alpha_o - \varepsilon)}{Q\, C_l + 1}$$

As the angles α and ε and the quantity $Q\, C_l$ were already determined earlier in the work, the application of this correction will involve very little additional work. It may be of interest to note that the correction $\Delta\varepsilon$ is always negative, which means that the stabilizer of a pusher machine must be set at a smaller angle than the stabilizer of a tractor machine for the same disposition of wings and location of the center of gravity.

Now we have obtained the expressions for the angles of incidence of the wings α and tail plane δ and of the angle of downwash ε and $\Delta\varepsilon$. We will assign plus sign to the angle of stabilizer setting β when this angle is measured above the wing chord, and minus sign when it is measured below the wing chord. The latter and more common case is shown in Fig. 1. Inspection of the Fig. 1 will allow us to write the following relation between different angles.

$$[18] \qquad \beta = \delta + \varepsilon - \alpha$$

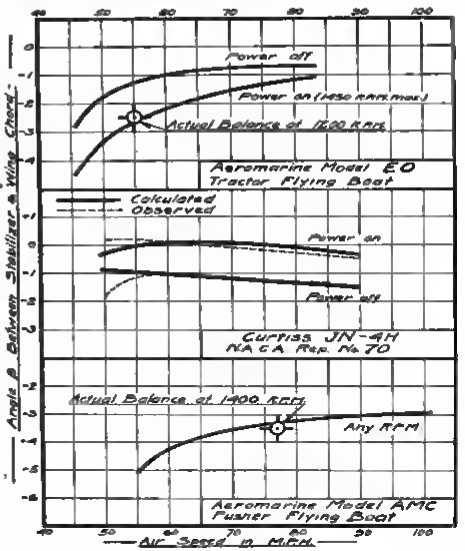

Fig. 2

In order to illustrate the practical application of the method described here and to give the reader some idea of the magnitude of the different quantities to be expected in this work, the computation of the balance coefficients is carried through in Table IV for three machines of widely different types. In Table V the computations of the stabilizer setting required for balance at the different speeds of flight are made for the JN4H airplane. Similar computations were made also for other two machines with the power on and off, and the angle of stabilizer setting required for balance is plotted on Fig. 2 against the speed of flight. The curves of required stabilizer setting for the JN4H airplane as determined by flight tests are also plotted for comparison. These curves were obtained from the curves of observed elevator setting given in Fig. 25 of the N.A.C.A. Rep. No. 70 by making the usual assumption that two degrees of elevator movement are equivalent to one degree of stabilizer movement. The stabilizer of this machine was thin and cambered on the top only, and was set at an angle of minus 2.3 deg. to the wing chord. This was assumed to be equivalent to minus 0.8 deg. of symmetrical stabilizer setting, as it was explained elsewhere in this paper. No special balance or stability tests were made on either Model EO or Model AMC flying boats, but the normal condition of good balance was estimated from the observations made during the trial flights and from the pilot's reports, and these observed conditions for each of the machines are marked in Fig. 2 by small circles. The data are somewhat uncertain in the case of the Model EO flying boat as the very light and effective controls of this machine made the pilot report the balance as "satisfactory" through a fairly wide range of the indicated air speed.

In finishing this peper it may be well to state that the assumptions and approximations made in the derivation of the formulas do not hold near the stalling speed, and that the method described above should not be used for values of the lift coefficient greater than ¾ of the maximum lift coefficient of the airfoil used, which sorresponds to a speed about 15 per cent greater than stalling speed.

TABLE II
POWER PLANT COEFFICIENTS

Engine	Hp	R p m	k_1	k_2	k_3	k_4	k_5
Lawrance A5	58	1450	6 5	0 035	0 72	480	1 17
Bristol Cherub	32 5	3200	5 3	0 023	0 48	1250	3 10
Wright Gale	80	1700	5 0	0 028	0 55	675	2 23
Anzani 6A3	75	1450	5 6	0 020	0 58	830	2 13
LeRhone 80	80	1250	5 0	0 031	0 61	770	1 95
Curtiss OX5	92	1400	5 7	0 025	0 57	690	2 27
Curtiss K6	150	1700	5 2	0 035	0 49	1150	3 37
Wright A and 1	150	1400	5 4	0 025	0 52	1160	3 02
Wright E4	150	1800	4 6	0 022	0 42	1350	4 72
Wright T	200	1700	5 3	0 023	0 44	1900	4 58
Hall Scott L6	210	1700	5 0	0 022	0 45	1860	5 73
Liberty 12	420	1700	4 8	0 015	0 37	2810	7 17

TABLE IV
CALCULATION OF BALANCE COEFFICIENTS FOR 3 MACHINES

Machine		I	II	III
Data Required				
1—Weight in lb	W	1410	2105	5130
2—Engine—Make and Type		Anzani 6A3	Wright I	Liberty 12
3—Engine horsepower	$\mathcal{P}$	75	150	420
4—Engine r p m		1450	1400	1700
5—Wing area in square feet	S	288	353	852
6—Tail plane area in sq ft.	s	32 5	40 3	88 5
7—Overall span in feet	b	38 0	43 5	65 0
8—Tail plane span in feet	b'	10 6	10 5	15 0
9—Mean aerod chord in feet	l	4 5	5 0	8 45
10—Main gap in feet	G	4 5	5 0	7 0
Location of Center of Gravity				
11—Relative to M A C in feet	y	1 6	0 0	3 5
12—Relative to thrust in feet	y'	3 7	—0 3	1 85
13—Relative to leading edge	x_0/l	0 33	0 35	0 34
14—From C P of tail plane—ft.	L	13 7	15 0	17 5
15—Angle of attack in Degrees	α_0	4 0	3 2	4 0
16—Lift coefficient	C	0 85	0 45	0 85
17—Moment coefficient	C_{mo}	0 073	0 073	0 073
Basic Relations				
18—Gap to span ratio	G/b	0 12	0 11	0 11
19—I coefficient	k	1 07	1 05	1 05
20—Effective span	kb	40 7	45 2	69 6
21—Effective aspect ratio	R	5 2	6 0	7 3
22—Tail plane aspect ratio	R'	3 1	2 1	2 5
23—$i = C1/(\pi/R)$		0 076	0 075	0 078
24—$i' = C1/(1 + 2/R')$		0 051	0 051	0 063
25—Loading per sq ft. in lb	W/S	5 3	5 2	7 8
26—Loading per hp. in lb	W/P	18 8	14 5	12 2
27—Power plant coefficient	k	5 3	5 4	4 5
28—Power plant coefficient	k_2	0 60	0 52	0 37
29—Power plant coefficient	k_3	2 12	3 02	7 17
30—Tail area coefficient	$L/Sl = B_0$	0 36	0 45	0 37
31—Tail moment coefficient	$B_0 w'$	0 061	0 078	0 071
32—Tail length ratio	L/l	2 8	3 2	2 7
33—Downwash coefficient	K	0 60	0 54	0 59
Balance Coefficients				
34—$D = \dfrac{\frac{y}{l} + \frac{1}{57.3\,n}}{\frac{L}{l} + \frac{y}{l}\frac{C_l}{57.3\,n}}$			—0 052	—0 038 —0 006
35—$E = \dfrac{\frac{1}{57.3\,n}}{\frac{L}{l} + \frac{y'}{l}\frac{C_l}{57.3\,n}}$			0 055	0 013 0 042
36—$F = \dfrac{\frac{1}{W}}{\frac{L}{l} + \frac{y'}{l}\frac{C_l}{W}} = k_4\sqrt{\dfrac{l}{S}}$			0 160	—0 022 0 113
37—$E = [13] + [35] - [36] - 0\,25$			—0 041	0 175 0 039
38—$G = \dfrac{y'}{l} - \dfrac{F}{W} - k_2\sqrt{\dfrac{W}{S}}$			0 041	—0 005 0 025
39—$H = 0\,00125\sqrt{R}$			0 047	0 059 0 039
40—$Q = k_3 s/R$			0 40	0 43 0 62
41—L' (for glide) $= [13] + [35] - 0\,25$			0 139	0 153 0 152

I—Tractor Sport Flying Boat Model EO built by the Aeromarine Plane and Motor Co for L D Osborn, and described in Aug 11, 1924 issue of AVIATION.
II—Curtiss JN4 with Wright I engine. The Data are taken from N A C.A. Rep No 10.
III—Aeromarine Model A.M.C Flying Boat (Morro Castle II) described in Oct 20, 1923 issue of AVIATION

TABLE V
CALCULATION OF STABILIZER SETTING FOR JN4H AIRPLANE

Lift		5 2	0 4	5 5	5 8	5 7	5 3	5 5	1 0
α in degrees		0 8	1 5	2 0	4 3	5 6	0 5	0 3	3 0
V lb and /hr		90	75	70	60	50	55	52	42
$D\ C_l^2$		—0 005	—0 004	—0 007	—0 010	—0 014	—0 012	—0 023	—0 028
$E\ C_l$	—	0 053	0 070	0 085	0 105	0 122	0 140	0 158	0 175
$G\ C_l^{1.5}$		—0 002	—0 003	—0 004	—0 004	—0 004	—0 004	—0 005	—0 005
Nomian									
tary		—0 054	—0 039	—0 055	—0 041	—0 028	—0 014	—0 002	+0 510
$Q\ C_l$		0 15	0 10	0 24	0 25	0 34	0 38	0 44	0 43
Determinator		0 030	0 033	0 035	0 338	0 041	0 044	0 048	5 351
β in degrees		—2 8	—2 1	—1 6	—1 1	—0 7	—0 3	—0 0	+0 2
ϵ in degrees		2 7	3 5	4 5	5 4	6 3	7 2	8 1	9 5
β in degrees		—0 5	—0 1	0 0	0 0	0 0	0 0	—0 2	—0 4

Bids Invited for Air Mail Routes

Sealed proposals will be received at the Post Office Department in the City of Washington until 4 30 p m of April 30, 1925, for carrying the United States mails on the routes hereinafter described from July 1, 1925, (or such subsequent date as the Department may order), to June 30, 1926, in safe and suitable aircraft as follows

From Landing Point (n.o) at Seattle, Wash , to Victoria, British Columbia, about 84 mi , and back, in close connection at Victoria with outgoing and incoming trans-Pacific mail steamers, but not exceeding an average of twelve (12) round trips a month, for the transportation of not to exceed six hundred (600) pounds of mail n single trip each way, by a schedule satisfactory to the Postmaster General, the contractor to receive and deliver the mails at a convenient location in Seattle, bid to state point at which he will dock, and to receive and deliver the mails from and to the steamships at Victoria Bids to state rate per round trip whether the return trip is performed same day as outbound trip or on days following. Bond required with bid, $2,000

From Landing Point (n o) in New Orleans, La., to Pilottown, about 80 mi , and back, or to Port Eads, La., about 92 mi and back, when practicable, in close connection at Pilottown or Port Eads with outgoing Central American and Havana, Cuba, steamers, and at Pilottown, or Quarantine, or Port Eads, with the same incoming steamers, daily except Sunday, for the transportation of not to exceed five hundred (500) pounds of mail a single trip each way, by a schedule satisfactory to the Postmaster General, the contractor to receive and deliver the mails at a convenient location in New Orleans, bid to state point at which he will dock, and to deliver the mails to the steamships at Pilottown or Port Eads and receive the mails from the steamships at Pilottown or Quarantine, or Port Eads. Bids to state rate per round trip whether the return trip is performed same day as outbound trip or on days following. Bond required with bid, $2,000

Proposals submitted will be subject to the Postal Laws and Regulations and to the conditions and requirements set forth in the Instructions to Bidders, copies of which, together with blank form of proposal with accompanying bond, can be obtained from the Second Assistant Postmaster General, Post Office Department, Washington, D. C , or from the Postmaster at New Orleans, La.

This notice is for proposals for continuance for one year of the present service, payment for which is made from the Appropriation for Foreign Mails and has no connection whatever with the Act of Feb 2, 1925, authorizing the Postmaster General to contract for carrying mail by airplane on inland routes.

Junkers Factory in Sweden

The Swedish press states that a factory will be established in Lambamn near Malmoe under the trade name Aktiebolaget Flyindustrie by the Swedish company Aerotransport and the Junkers Works They are beginning the manufacture of the large all-metal Junkers commercial machine and the Junkers aircraft engines, which are derived from the BMW designs acquired by Professor Junkers some time ago. This is another German effort in nearby countries which is enabling them to continue their aircraft development despite the Inter-Allied Control commission This is also expected to form another bond between the Swedish and German air industries.

Quiet Birdmen

The date of meeting of the Quiet Birdmen has been changed from Wednesday to Monday beginning April 20. All members are requested to take notice of this change

LIGHT PLANES AND GLIDERS

Edited by Edmund T. Allen

The Question of Duralumin Welding

The use of duralumin in building light planes is undoubtedly on the increase. Its advantages for lightly stressed parts are very great. There has been, especially in England, a strong antipathy to its use owing largely to the unreliability of the earlier material Its reliability now, however, is unquestioned as far as uniformity is concerned And innumerable tests have proven that when a certain annealed or heat treated tube is specified as of, say, 35000 ar 55000 lb/sq in. tensile strength, it will stand up in the testing machine to that stress. Duralumin as a light plane material has now almost as many advocates as opponents. Its chief difficulty lies in the problem of making the connection between two pieces or between the duralumin and another material

This is usually solved by fittings riveted with small tubes headed over at the ends. Often elaborate fittings are made up for such connections. The cost of such work is prohibitive for the small builder, and he must usually look elsewhere for production processes. Especially in fuselage construction, when one would wish, for simplicity, to make the many attachments of Warren truss members to longerons, is it necessary to develop connections that will be as strong as the pieces themselves

One of the first workers in this field is Charles Ward Hall of New York City who recently completed the all-duralumin Navy scout illustrated in AVIATION. It is in fact a redesigned TS with the Wright radial engine. Although the gross weight of this scout with its full military load is 1750 lb, the bare fuselage structure weighed but 24 lb. The fittings in this case were all specially constructed and were designed to develop the full strength of the tubing, but their cost on a single machine is very great It is only in large production that the cost of such construction would go down. Dies, heat treating and annealing baths, special tools for working the metal, and the aspertness of the workmanship required make the single experimental product a highly expensive proposition

Fasig and Charles, who had the light biplane in last year's Detroit races, appear to have been successfully welding duralumin for some time. It would seem at first that welding the duralumin tubing would solve at once this whole problem of the fuselage as it has for steel tube fuselages. But difficulties of obtaining a good weld are very great, and, of course, the welded structure, if not re-heat-treated, is reduced in tensile strength to its annealed state. Mr. Charles, who has developed a high degree of skill in welding duralumin, seems to have solved the first of these difficulties satisfactorily. A sample which was tested in the Columbia University Laboratory six months after it was welded showed no signs of aging failure and did not break at the weld at all The sample broke at a tensile strength of 34100 lb /sq in., approximately the tensile strength of the annealed material. If it were possible to heat treat the heated parts again after the welding, one might realize the full 63,000 lb /sq in. of heat treated duralumin This would be a very expensive process, however, especially if it were necessary to build a heat-treating bath large enough for an entire fuselage. Possibly processes of immersing welded joints or building small baths around joints could be developed more cheaply.

On second thought, however, it appears that perhaps this elaboration is not necessary for in designing fuselage trusses the limiting factor to be considered is the Euler* load in compression of the member between strut points, and this Euler load limits the stress practically always to a point far less than the tensile value of even annealed tubing It appears that welded duralumin construction, if the welds were always as good as the Fasig-Charles job, would be entirely satisfactory for the rear of the fuselage and probably in light planes for the entire fuselage structure. Caution is, of course, necessary especially in the matter of possible deterioration at the weld owing to the annealing of the material If some method of applying local heat treatment to the weld could be developed, the possibility of even this might be eliminated. In the case of the Fasig-Charles sample tested no such action had taken place after six months It is understood that the Fasig-Charles organization is planning to make up a welded duralumin fuselage for their new 1925 light plane. We shall watch with interest their progress.

*Eulers formula for long struts in compression $P = \alpha\dfrac{\pi^2 EI}{L^2}$, where

P = the ultimate allowable load
E = the Modulus of Elasticity of the material
I = the Moment of Inertia of the section
L = the length between points of support
and α = a factor Depending upon the fixity of the ends
α = 1 for pin ended struts (round ends)
α = 2 for most fuselage members where ends are welded
α = 4 for absolutely fixed ends.

More Details on the Nine Hour Glide

In 1921 when the Germans stayed in the air for 23 min. without any form of motive power except that of the wind, the whole world was astonished and considered it a marvelous feat. However it was soon realized that gliding was a matter of choosing a location where the configuration of the ground and the strength of the wind was such that the air was given a strong upward velocity Given these conditions, gliding becomes a matter of skill and endurance on the part of the pilot, but the number of hours which the pilot stays in the air are more an indication of his endurance, than of the efficiency of the machine

Since 1923 Lieutenant Thoret, an instructor in the French Air Service, has been flying to a favorable location, cutting his engine entirely and gliding In 1923 Lieutenant Thoret glided in this manner for 7 hr at Biskra in Algiers and since that time he has done some 50 hr more in gliding flights of various lengths. He has also been initiating students to the art of gliding and one of these Sergeant Wernert has recently flown for 9 hr. 17 min. with his motor absolutely stopped The type machine used is a Harriot HD14 training plane which has a very light wing loading. On the day that Wernert made his record, there was a high wind blowing and he found a zone of up current almost 2 km. wide and 4 or 5 km long. Sergeant Wenert for the most part flew from 50 to 300 yd above and in front of the ridge which caused the up current at all times maintaining a great reserve of flying speed. He tacked up and down in front of the hill all day and toward sunset the air became very disturbed due to the cooling of the air in the shadow of the hill. A perfect landing was made by moonlight.

Both Wenert and Antoine were good pilots before they were taught the art of gliding The gliding instruction as given by Lieutenant Thoret consists of practicing the maneuvers necessary for gliding flight under normal conditions, that is by getting altitude with the engine and executing various maneuvers during the glide to earth, first with the engine throttled, and then with the engine cut entirely When the student becomes proficient in handling his plane during the glide he is flown to a point above the crest on a day when the wind is only blowing moderately, he practices with the motor throttled and as he grows more expert he goes out on windier days and gradually reaches a point where he can handle the machine in a wind sufficiently strong to keep the machine in the air with the engine completely cut off. It is claimed that practice of this sort makes a very expert pilot

AIRPORTS AND AIRWAYS

Belleville, Kan.

By C H Hedges

The airport has now been established, and is only four blocks from the city square A four plane hanger is to be built immediately, and it is expected to house three "Swallows." Belleville is considered by local authorities to be at the cross-roads of America, being at the intersection of the Meridian, and Ocean-to-Ocean airways. It is on the airline from Kansas City to Denver as well. A flying school will be opened at the airport this summer.

Okefenokee Mishap

Bonnie Rowe and Hal Taylor, of the Desch Flying Circus, were lost in the great Okefenokee Swamp in Georgia, for two days during March Rowe was flying from Waycross, Ga., to Jacksonville, Fla., when they had a forced landing in the middle of the swamp The plane was a total wreck. They stayed together for one day and then separated Taylor, being the first to get back to civilization. His experiences were so terrible that he was compelled to go to the hospital Rowe did not get out quite so soon, but was in a little better condition This adventure should serve as a warning for other aviators flying over the district, and the swamp itself should be avoided, as a forced landing means practically certain loss of the ship, and perhaps death to the aviator.

Spokane, Wash.

By E H Partridge

Col Frank P Lahm, air chief of the ninth corps area, reviewed troops of the 116th national guard air squadron in Spokane on Sunday, March 29 Colonel Lahm is one of the oldest fliers in the world, holding airplane pilot's license No 2, dirigible pilot's license No 2, and spherical balloon pilot's license No 3 He learned to fly on one of the first Wright biplanes. It was the first time he had visited the newly organized air squadron

Mercedes-engined Standard, which crashed a year ago near Carlew, Wash has been given temporary repairs and arrived in Spokane recently Fred Rice, garage man, bought the plane from J. McMillan

Pilot Nick B Mamer has bought a second 150 hp Hispano-engined Standard It was acquired at a government auction, federal officials having seized the plane two years ago after it had been caught unloading a cargo of whisky It was said to be the first booze airplane ever seized by government officers. He operates two ships.

Two Spokane pilots plan to submit bids on the proposed air mail route from Pasco, a railroad center in Washington, to Elko, Nev on the Coast-to-Coast air mail route. Specifications require capacity for 250 lb of mail and in addition space for two passengers, according to information The distance is about 400 mi., air line.

Lieutenant Mamer and Lieut. Tom Symons probably will be designated to fly two guard planes from San Diego to Spokane A third pilot will be selected later Three ships are ready to be brought north.

D. R Wallace has purchased a Standard plane formerly owned by C E Stillwell.

Fort Worth, Tex.

By George F. Buchof

It does look like Jubilee Field will be lost. Just as the field is about to be popular for flying the owner of a small make a little money. The report is he wants to double the rent now that the management of the field has a chance to make a little money. The report is he wants to double the rent for his portion of the field and the balance of the owners are getting nothing for theirs. If this is a fact or becomes a fact the building will be abandoned and other arrangements made

The rent per month which is now being paid will actually buy the same kind of a place. Fortunately there are other fields convenient to the city of Fort Worth which can be utilized and made into nice flying fields and there is every reason to believe that one owner is to turn his land into just that very thing; this field is nearer the business district and would make an ideal field.

Fort Worth is yet sleeping not a sound coming from any direction that would be financially able to help this city to a municipal field, Fort Worth's municipal field is now abandoned as such, no planes landing there any more is the facilities were unsatisfactory

And while nothing is being done in Fort Worth her rival, Dallas, is doing nicely, planes landing there continually, even the army sending an instructor to that place once a week.

Boston, Mass.

By Porter Adams

We would like to know just how much the spring weather is responsible for the optimistic attitude which is beginning to prevail hereabouts in regard to aviation. Scarcely a day goes by without some sort of a notice in the press regarding a proposed air line with Boston as one terminal. First it was the Boston-St Paul route announced by Colonel Hartney, then several hints of a Boston-New York service to connect with the air mail, and more recently a report from Fitchburg, Mass, that an effort has been made to obtain a landing field there for a proposed Boston-Albany service. All of Harold Hartney's many friends hereabouts are much interested in his plans and hope that they are sufficiently advanced to require his extended presence in Boston in the near future

* * *

A shade of sorrow appeared however with the report from the War Department that private aircraft will not be permitted to use active air service fields, except in an emergency and that use of inactive ones will only be permitted after the deposit of a five thousand dollar bond. The news was as distressing as it was unexpected and we have considerable curiosity to learn just where the order originated as the co-operation and assistance of the Air Service has been one of the main hopes of people interested in establishing commercial aviation Boston however is more fortunate than most cities for although the actual administration of the Boston Airport is under the Army, there is a provision in the lease reading as follows

"AND it is also understood and agreed that the Lessor (the Commonwealth of Massachusetts) reserves full rights and authority to grant permits which shall be recognized and honored by the Lessee (The Army) its agents and representatives giving to commercial and other non-military aviators who may be approved by the Secretary of War the privilege of using said field jointly with the Lessee under the same rules and regulations that shall apply to the use of said flying field by Army organizations." All of which seems to let Boston out, and so long as we confine our flying to our own Airport we shall probably not be subjected to military arrest.

* * *

On March 26 during the visit of Major General Fries Chief of the Chemical Warfare Service, a Martin Bomber from Aberdeen laid a smoke screen along the Charles River in front of Technology The afternoon papers reported that it had been witnessed by half a million people and it obtained more public attention than anything aeronautical here since the landing of the World Flight.

* * *

A new corporation has been formed with offices in the Park Square Building for the purpose of aerial advertising They report that they will soon start operating using a Curtiss Oriole.

Boston's own World Flier, Lieut. Leigh Wade was again in Boston recently, telling the story of the World Flight at Billerica on the 25th and at Attleboro on the 26th. Lieut. Leslie P Arnold also talked of the flight at the City Club, Boston, on the evening of the 26th and they both returned to New York on the night train.

* * *

The National Aeronautic Association films were shown to the Aeronautical Engineering Society of the Massachusetts Institute of Technology on the afternoon of the 23rd and at the Engineer's Club, Boston in the evening Word has been received here that the new Chapter of the N.A.A known as the State of Maine Chapter, at Augusta, Me., has received its charter and will elect officers in the near future. This chapter was obtained through the splandid work of Hon. William H. Gannett, of Augusta, the Governor of the N.A.A. for the state of Maine. Its membership includes many of the most prominent people in the state administration, and because a large number are State Senators and Representatives the time of the chapter is considered especially appropriate

* * *

England may have its Ted Grey, but this lad Caldwell is the son of our young life. We even skip the publisher's new letter until after we see what Cy has to say and we hope his column will become a regular feature for he is just as intriguing as consin Charlie and its our humble opinion that some of his guesses may come considerably nearer being right

* * *

With several cross-country flights to its credit, one reaching half way across the continent, with the visit of the big Martin bomber from Maryland for the smoke-screen demonstration of Thursday over Boston, and with the sun flashing on the new silver paint of Navy seaplanes flying now after a winter in their Squantum hangars, Boston in the seventh week of its 1925 flying, more than doubled its best week's time this year. Fifty-eight hours and ten minutes is the total for the week for planes of the Army, National Guard and Navy. Eighteen hours and thirty minutes is credited to Lieut James H Doolittle, U.S.A., and his fellow classmate at M I T, Lieut G D Townsend, U S N., who went to McCook Field near Dayton, Ohio, and flew back a new DH4M1 in 1010 min flying time

The seaplanes added a picturesque touch to the Charles River Basin smoke screen demonstration Thursday The bombing plane which carried the smoke apparatus, returned to the Aberdeen Proving Ground in Maryland on Thursday afternoon Two local pilots made trips to New York during the week, round-trip time being 260 and 270 min., respectively.

* * *

The National Guard are decorating the planes of the 101st Aero Squadron with their insignia, a flying seagull, white, on a circular field of turquoise blue. Paul Seavey is doing the painting

Canary Islands Airway

The first step toward the establishment of an air service between Spain and South America was taken on Feb. 8, when the Spanish Government issued a decree providing for the creation of an aerial mail line to the Canary Islands The decree provides that the concession for this service be awarded to a strictly Spanish corporation, which shall be entitled to the benefits of the decree relating to grants in aid of national industries.

The chief features of the proposed air service are

1 A weekly round trip, increasable to two or more a week if required by the postal service, on days and hours which the Director General of Communications shall fix

2 The service shall be rendered by machines having a minimum speed of 140 km./hr. when fully laden, a radius of action of more than six hours' flight at full speed, and a cargo capacity of 600 kg. which shall be reserved for mail

3 The machines shall have two or more engines and shall be equipped with wireless

4 The services shall be rendered in the following order: From Seville to Larache to Mogador or Agadir, from Mogador or Agadir to Capa Juby in land planes, from Cape Juby to Las Palmas; and from Las Palmas to Santa Cruz de Tenerife in amphibious planes.

5. There shall be principal air stations at Seville, Las Palmas, and Teneriffe, all provided with such hangars and other equipment as may be deemed adequate for the successful operation of the line. The department of Government, in cooperation with the Bureau of Civil, Military, and Naval Aeronautics shall have charge of supplying equipment.

6 The life of the concession shall be ten years, renewable for the same length of time by the common consent of the contracting parties, if considered advantageous to the interests of the administration.

1925 German Connections

It is reported by the Commercial Attaché, Berlin that during the coming spring the German Aero Lloyd (Deutsche Aero-Lloyd-Gesellschaft) and the Junker Airplane Transportation Co (Junkers Luftverker A. G.) will maintain or take part in the following airplane connections:

Berlin-Hanover-Amsterdam-London, Berlin-Danzig-Koenigsberg, Koenigsberg-Riga-Reval-Helsingfors, Koenigsberg-Smolensk-Moscow, Danzig-Stockholm (partly by night), Berlin-Leipzig-Fuerth-Nuernberg-Munich-Innsbruck, Frankfort-Fuerth-Nuernberg Munich, Geneva-Zurich-Munich-Vienna-Budapest, Zurich Stuttgart Mannheim-Frankfort-Dortmund-Bremen-Hamburg, Bremen-Hamburg-Copenhagen-Malmo, Hamburg-Bremen-Amsterdam-London, Berlin-Copenhagen-Malmö, Munich-Stuttgart-Baden Baden, Berlin-Warnemunde-Stockholm, Berlin-Stettin

Laguna, Mexico

A Mexican firm has purchased an airplane in the United States, with the expectation of starting an aerial transportation company in the Laguna consular district according to Consul Bertley F. Yost. Present plans include the location of a hangar on the automobile road between Torreon, Coahuila, and Lerdo, Durango, with arrangements for long distance trips to such other towns as Monterey, Chihuahua City and Saltillo. A flat rate of 35 pesos ($17.50) a trip for one passenger anywhere in the Laguna has been made

Movie Flying

Aviators connected with the motion picture industry have been active in Southern California this year, and several pictures utilizing airplanes have been completed in the months of February and March. Others are in prospect, and two fliers, Al Wilson, a noted stunt aviator, and Edward Unger, pioneer balloon man, are heading their own producing concerns. Wilson is working on a series of aviation pictures which involve new stunts.

The Lesky-Paramount people have completed a feature picture, "The Air Mail," which is based on the hazardous work of the postal aviators on the transcontinental service. Considerable of the flying in this was done in Nevada by Howard Patterson with Reginald Balmer's sport plane, the "Constanes." Some of the scenes were taken in old deserted mining towns, once bonanza communities but now without population, although large bank, school and other buildings are still standing.

Capt Bogart Rogers is with Douglas MacLean, whose airplane pictures are already well-known. Jeanie Macpherson, who is a trained aviator as well as a famous scenerioist, is with the new organization of Cecil de Mills at Culver City. The Universal company, which began taking flying pictures in 1910, is shooting aviation scenes on new pictures at Universal City. Frank Clark and other leading fliers at Clover Field are devoting most of their flying time to motion picture work.

Dallas Courtesy Card

The Dallas Flying Club cooperating with the Chamber of Commerce has issued a courtesy card for visiting U. S. Army Aviators. This card is given out to all army aviators who stop off at Dallas and enables them to get reduced rates at certain hotels and restaurants and free admission to a number of theaters.

The Dallas Flying Club holds a luncheon every Friday in the Y.W.C.A building to which all visitors are cordially invited. Night classes in aviation matters are also given to the members of the club, to Reserve Air Service Officers and to others interested in aeronautics. The lectures are delivered by officers who are detailed from Brooks Field

UNITED STATES AIR FORCES

U. S. ARMY AIR SERVICE

Purchute Experience

The following is the report of Cadet Charles A. Lindbergh who saved his life by jumping from an aerial collision on March 6 at Kelly Field.

"A mass ship SE5 formation commanded by Lieutenant Blackburn was attacking a DH4B, flown by Lieutenant Maughan at about a 5000 ft. altitude. I was flying on the left of the top unit. Lieutenant McAllister was on the right and Cadet Love leading. When we nosed down on the DH4B, I attacked from the left and Lieutenant McAllister from the right. After Cadet Love pulled up I continued to dive closer to the DH before pulling up to the left. At this time I saw no other ship nearby.

"I passed by the DH and a moment later felt a slight jolt followed by a crash. My head was thrown against the cowling and the plane seemed to shift position and hang nearly motionless for an instant. I closed the throttle and saw Lieutenant McAllister in his SE5 on my left. He was apparently unhurt and getting ready to jump.

"Our planes were locked together with their fuselages approximately parallel. My right wing was damaged and folded back slightly, covering the forward right hand corner of the cockpit. Then the wires began to whistle, the ships started pulling around and the damaged wing commenced vibrating and striking my head at the bottom of each oscillation.

"I unbuckled my belt, climbed out past the trailing edge of the right wing with my feet on the cowling on the right side of the cockpit, which was then nearly vertical, I jumped backward as far from the plane as possible. The wreckage was falling nearly straight down when I jumped and for some time I fell in line with it and only slightly to one side. Fearing the ship would fall on me, I did not pull the rip cord until I had fallen several hundred feet.

"There had been no falling sensation and as soon as I pulled the rip cord the risers jerked on my shoulders, the leg straps tightened and the chute was fully opened. I saw Lieutenant McAllister floating above me and the wrecked ships pass about 100 yd. to one side, continuing to spin to the right and leaving a trail of lighter fragments along their path until they crashed in the mesquite about 2000 ft. below, to burst into flames a few seconds after impact.

"Next I turned my attention to locating a landing place. I was over mesquite and drifting in the general direction of a plowed field which I reached by slipping the chute. Shortly before landing I was drifting backward but was able to twist around in the harness just as I hit on the side of a ditch less than 100 ft. from the mesquite. Although the impact of landing was too great for me to remain standing, I was not injured in any way."

Army Air Orders

Maj. Carlyle H. Wash, A.S., Asst. Military Attache, Paris, to Washington.

Sec. Lt. Francis Robert Stevens, A.S., Brooks Field, to Inf. Fort Sam Houston.

First Lt. Howard C. Brandt, A.S., Chanute Field, to New York City, sailing on Government transport Aug. 11 for Hawaiian Is.

First Lt. Leonidas L. Koontz, A.S., McCook Field to San Francisco, sailing June 17 for Philippine Is.

First Lt. Norman D. Brophy, A.S., upon completion of foreign service, to San Antonio.

Appointment Tech. Sergt. Henry Herbert Ogden, A.S., as second lieutenant A.S., Reg. Army announced.

Sec. Lt. Leonard Stanley Flo, A.S. Res., Omaha, to active duty Selfridge Field, reverting to inactive status June 30.

Maj. Byron Q. Jones, A.S., appointed acting quartermaster Off. Ch. A.S.

Promotion Capt. Henry Jervis Friese Miller, A.S., announced.

First Lts. Clarence H. Welch, A.S., Kelly Field, to Aberdeen, Md.

Priv. William L. Davis, A.S., Bolling Field, to Langley Field.

Priv. William H. Purnell, A.S., Langley Field, to Bolling Field.

First Lt. Charles H. Mills, A.S., relieved duty A.S. Tech. Sch., and will report to Com. Off., Chanute Field.

Sec. Lt. Joseph Aloysius Kielty, A.S., Brooks Field, to Inf. Fort Sam Houston.

Sergt. Raymond Vis, A.S., Mitchell Field, to Hartford.

Capt. Charles B. Oldfield, A.S., designated Asst. Com. A.S. Prim. Fly. School, Brooks Field.

Vice. Capt. Paul T. Bock, A.S., relieved as Asst. Com. A.S. Prim. Fly. School, Brooks Field.

Sec. Lt. Felix Marcinski, A.S., Brooks Field, to Fort McIntosh.

Sec. Lt. Frederick Harper Wilson, A.S. Res., Washington, to Hampton.

Brig. Gen. William Mitchell, Asst. Ch. A.S., Washington, to Fort Sam Houston.

Capt. Carl W. Connell, A.S., Govern. rep. Boeing Airplane Corp., Seattle, to San Francisco, sailing July 7 for Panama.

Lt. Col. James E. Fechet, A.S., Kelly Field, to Washington.

Maj. Millard F. Harmon, jr., A.S., Washington, to Bolling Field.

Following officers A.S. designated ex students at Coms. & Gen. Staff. Sch. for 1925-1926 course and will report Fort Leavenworth: Lt. Col. Arthur G. Fisher, Maj. Jacob E. Fickel, Maj. James E. Chaney, Maj. John H. Birle, Maj. Frederick L. Martin, Maj. Walter H. Frank, Maj. Lewis H. Brereton, Maj. Clarence L. Tinker, Maj. Percy T. McNarney, Capt. David S. Seaton, Air Serv. Tact. Sch., Langley Field, Maj. Davenport Johnson, 1st Obs. Squad., Mitchel Field, Capt. Howard J. Houghland, 12th Obs. Squad., Fort Sam Houston.

Lt. Col. Clarence C. Culver, A.S., Fort Sam Houston, to Kelly Field.

U. S. NAVAL AVIATION

Navy Planes Will Explore Arctic

Naval aircraft and Navy pilots will be assigned to the MacMillan Arctic Expedition, which will penetrate the far North during the coming summer, and in the words of MacMillan "Accomplish more with the use of airplanes than has been accomplished in Arctic exploration during the past century."

There will be two planes assigned by the Navy Department to the Expedition. The planes will have a cruising range of more than 1,000 mi. The pilots and aviation personnel for the expedition will be selected from volunteers from the Naval Aviation personnel. Lieut. Comdr. R. E. Byrd, who at present is on duty in the Bureau of Aeronautics of the Navy Department, will have charge of all flight operations in connection with the expedition. The Navy's participation in the expedition has the endorsement of President Coolidge who was consulted by Secretary Wilbur with respect to the assignment of Navel planes and pilots.

A comprehensive survey of the Arctic regions lying to the northward of the American Continent expresses in general terms the objects of the expedition. The prize in sight which MacMillan confidently predicts will be attained, is the survey of the only remaining blind spot on the map of the world—a region of more than a million square miles in extent lying between Alaska and the North Pole. Here is believed to be an Arctic Continent which has never been viewed by man.

It is planned to use the amphibian type of plane which will be able to take off and land on water or smooth ice. It is expected that the Loening Amphibian will be used and the Army Air Service has been asked to cooperate in the loan of this type pending the receipt by the Navy of similar planes now on order which would not be delivered in time.

According to present plans MacMillan's ships which have been chartered will leave Wiscasset, Me., about June 15 and proceed northward skirting the Labrador Coast as far as Maine. From here Davis Strait will be crossed to the Greenland shore. The expedition will push northward through Baffin Sea and across the dread Melville Bay (where the worst ice conditions of the voyage are anticipated) to Etah. If ice conditions permit, MacMillan will proceed through Smith Soand to Keonedy Channel and from this vicinity will base further operations.

In this locality the air assault on the impregnable Arctic wastes will be launched. The airplanes under the direction of Lieutenant Commander Byrd will attempt to establish an advance base at the northern point of Axel Heiburg Land. They will make a series of portage flights from the ship to the advance base carrying quantities of fuel, food and other supplies. This base will be established at a distance of approximately 250 mi. by air line from the probable location of the ship.

Working from the advance base on Axel Heiburg the planes will fly out over the great unknown regions of the Arctic. The flights will strike first in the direction of the problematical Crocker Land. This illusive domain has been reported several times in the history of the Arctic and has been drawn in, and erased from maps of the Polar area. Peary estimated it to be 120 mi. from Axel Heiburg. MacMillan explored 150 mi. in this direction without locating it. But at the point from which he turned back he described what appeared to be land masses rising above the horizon. With aircraft a thrust can be projected into this area which in two or three hours will do more than had been accomplished by weeks and months of laborious toil on dog sleds. The central portions of Axel Heiburg land will be explored from the air. The planes will fly over the Greenland Ice Gap obtaining valuable scientific data and a photographic record in these two regions where no man has ever before penetrated. Complete air equipment will be carried for scientific observations and records. The temperatures of the upper air strata of the Arctic will be recorded and may furnish new information of meteorological phenomena of the far North. It is altogether probable that the planes will find warmer temperatures at increased altitudes because of the 24 hr. of sunlight which characterize the Arctic day in summer. Travel through even the known localities of this region has hitherto been on the surface and it is believed that the lower temperatures encountered are due to the refrigeration effect of the hold-over ice from the frozen winter months.

Complete photographic equipment will be included in the expedition including motion picture cameras, still picture cameras and mapping cameras. The mapping cameras which will be installed in the planes will be capable of continuous running for two hours. They will make an accurate map of the territory over which they fly such as would probably never be made in the next century by other means. Baffin Land in the vicinity of the magnetic north pole will be mapped by this method as will also Ellesmere Land. The photographic equipment will be supplied by Fairchild.

The radio equipment of the expedition will be of especial interest. In the words of E. F. McDonald of Chicago who is giving particular attention to these details "we will write radio history in the north this summer." Sets for transmitting on 20, 40, 80 and 180 m. will be carried. With the 20 m. set, communication with the outside world is expected to be possible not only in code but by voice. The radio operator for the expedition will be John L. Reinartz the famous amateur and experimenter with high frequency transmission. Two other members of the expeditions as at present constituted will be U. J. Herrmann of Chicago and Ralph Robinson. The latter has been an assistant to MacMillan on five of his previous expeditions.

The expedition which has been projected this summer will be the ninth that MacMillan has undertaken in the Arctic. He was associated with Peary in his historic polar work and has in later years carried on the lifework of his former chief under his own direction. The use of aircraft and short wave radio in the present undertaking gives promise of results that could in no other way be attained, and MacMillan sees in this feature the opportunity for crowning a lifetime of effort with magnificent achievement in the interest of science, discovery and American prestige.

Volunteers to date from Navy and Marine Corps personnel to take part in the MacMillan Arctic Expedition as pilots or aviation mechanics have totalled forty-three, consisting of 24 Naval Officers, six Marine Corps Officers, eleven Navy enlisted men and two Marine Corps enlisted men.

Shenandoah Has Hot Mess

Warm meals for the crew and passengers of the Navy's rigid airship, the U.S.S. Shenandoah, are now assured while the ship is sailing. On her former voyages, coffee heated over the engine exhaust constituted the only hot article of diet on their menu.

This will be possible owing to the development of an aerial cook stove of a special design, which will be installed on the Shenandoah for use in future operations. The stove is operated by electricity and has thermostatic control in each of its three ovens. The stove weighs only 219 lb. complete with its utensils. It could be used in a hall room in housekeeping of the lightest variety. It is only 4 ft. long, 2½ ft. high and 2 ft. broad.

Despite its small dimensions and its lightness, the current of electricity is capable of heating the stove to 450 deg. Fahrenheit, when the outside temperature is down to zero. To keep this heat in the oven, one inch thick walls of special insulating material weighing 15 lb./cu. ft., are provided around the oven. The current is furnished by a two-tweety radio generator, run by a small gasoline engine. An automatic cut-off is provided, which cuts off the current to the stove when the radio, which requires all power available, is being used.

Naval Air Orders

Lt. Comdr. Homer C. Wick, det. Aircraft Sqds., Battle Flt. to Nav. A. Sta., Anacostia.

Lt. Comdr. Donald M. Carpenter, Det. Aircraft Sqds., Battle Flt. to Nav. A. Sta., Pensacola.

Lt. Emile Chourre, Det. Nav. A. Sta., Pearl Harbor, to Annapolis.

Lt. Ralph Wyman, det. Aircraft Sqds., Scig. Flt., to Nav. Air Sta., San Diego.

Lt. Comdr. Wallace L. Lind, det. Nav. Air Sta., San Diego, to U.S.S. Arizona.

Ch. Boat. John B. Carroll, det. U.S.S. Tanager, to Nav. Air Sta., Lakehurst.

Following officers from stations designated to Nav. A. Sta., Pensacola, Lts. (jg.) Harry A. Brandenburger, det. U.S.S. New Mexico, David E. Carlson, det. U.S.S. Melvin, Ensigns James R. Andrews, det. U.S.S. McCawley, Ralph J. Arnold, det. Battle Fleet, Thomas F. Carlin, det. U.S.S. Farragut, Charles F. Coe, det. U.S.S. Litchfield, Joseph L. Kane, det. U.S.S. Mississippi, George W. Lehman, det. U.S.S. Oklahoma, Mallish M. Lindsay, det. U.S.S. Mississippi, Earl Mueser, det. U.S.S. Thompson, Mathias M. Murphy, det. U.S.S. Litchfield, George W. D. Covell, det. U.S.S. Kidder, John B. Moss, det. U.S.S. California, Alfred C. Olney, det. U.S.S. Idaho, John V. Peterson, det. U.S.S. Tennessee, Harry Sanders, det. U.S.S. California, Zeus Soucek, det. U.S.S. California, Claude F. Sullivan, det. U.S.S. Maryland, Thomas B. Williamson, det. U.S.S. Tennessee, Joseph E. M. Wood, det. U.S.S. Mississippi.

Lt. (jg.) Allen D. Blacklodge, det. Nav. A. Sta., Pensacola, to Naval Acad., Annapolis.

Lt. Edward D. Graffin, det. Nav. Aircraft Fact., Phila., to Quantico, Va.

Lt. Ira P. Griffen, det. Navy Yard Boston, to Phila.

Capt. Thomas T. Craven, det. Com. Nav. Air Sta., San Diego, to Com. U.S.S. Maryland.

PUBLISHER'S NEWS LETTER

If you were to see in the news columns of AVIATION an account of the cost of aircraft to the navy with the heading, "Secretary Wilbur figures each Bomber costs Navy Million and Half," you would place it in a class with other aeronautical mathematical gymnastics which seem to give so many persons an opportunity to exercise their actuarial skill or whatever you choose to call it. But this cost seems inescapable from the figures given by the Secretary at the launching of the Saratoga, although he probably did not have this total in mind when he spoke. As will be seen from the address given after the launching, printed elsewhere in this issue, Mr. Wilbur referred to the statement of Admiral Sims in which he said that he would rather have one thousand bombing planes at $45,000 each than a battleship, and carried the assertion to its logical conclusion from the navy point of view. The Admiral, no doubt, thought of bombing planes as a protective force for a country, and as such required no naval carriers. The Secretary, however, sees in bombers a naval weapon comparable to the big gun, the cost of which is not the gun itself, but the cost of placing it where it will be of service to the fleet.

* * * *

First, he says that it cost the navy a million dollars for each thousand tons of aircraft carrier, and this tonnage is required to transport one bombing plane. He then tells us that the cost of the shore establishments of the Navy is about equal to the value of the floating navy, and to make the proposed addition to the air fleet would require a substantial addition to the present shore facilities, "Probably not equal in value to the cost of all the carriers, but at least a substantial addition." Inasmuch as the aircraft carrier is a highly specialized ship the "substantial" additional facilities required would probably equal one half the present facilities required for battleships, or at the rate of a half million dollars for each bomber that a carrier can accommodate. Next this weird cost statement places the value of the fighting and spotting planes in the total. As there are to be 41 of these planes on the Saratoga, in addition to the 31 bombers, for each bomber there would have to be about $33,000 worth of auxiliary planes. So, it will be seen that with the cost of the bomber itself, $45,000, the total cost to the Navy of each bomber would be $1,578,000.

* * * *

But the Secretary gives us further expenses in the form of upkeep, when he includes the cost of the additional naval personnel that would be required for the additional carriers. This he estimates at a million dollars a year for each carrier or at the rate of over $30,000 a bomber. In fairness to this method of cost finding we feel as Mr. Wilbur did when he said: "Of course I do not pretend to say that I have correctly portrayed the mental operations of this witness, but the suggestion illustrates the implications involved in a substantial addition to the naval air force." The main point to be noted from these huge expenditures is that great sums of the people's money will have to be used to protect the battleship, or for the use of aircraft in naval warfare. The reasons given for this development is that aircraft are so limited in their present development that they require ships to carry them to sea, "on the backs of the fleet," as Admiral Moffet said in his address. Air people, we believe, will feel that if the cost of several aircraft carriers was expended in the development of both airplanes and airships, that the range and other qualities could be so improved that they could operate without such great capeadditures for purely naval adjuncts. Witness, the proposed non-stop flight of the PN9 from California to Hawaii—2000 miles.

* * * *

It would be still more interesting to have the Navy make a comparison of the cost of the bombing plane with the big gun. The Colorado Carries eight 16 in. guns. The cost is given by *The World Almanac* at $25,030,311. Using the method of the Secretary in figuring the cost of bombers, there would have to be included the cost of the auxiliary ships which have been figured at about the same as the battleship or roughly $50,000,000 for each eight guns. Then as the shore establishment according to Mr. Wilbur is about equal to the value of all the vessels of the navy, another $50,000,000 must be added making $100,000,000 for each 16 in. gun or $12,000,000 a gun. Of course the absurdity of such figuring is apparent, but it is equally fantastic to build up huge totals for aircraft for the purpose of giving the public the impression that naval aviation is so costly.

* * * *

Following the enactment of the Kelly Bill which permits the Postmaster General to make contracts for the extension of the Air Mail with private operators, there has been a veritable snow storm of requests for information about this new possibility. Nearly five thousand communications have been received from all sorts of enquirers as to the new plan. With the proposition clearly stated in the bill the interest is very encouraging. The Air Mail is the only transportation method that carries mail exclusively. All others carry mail as an incidental part of their main activity. This is sound practice and will doubtless come about in the no distant future with the carrying of mail by air. Meanwhile the pioneering work of the Post Office Department in this field has brought to this country the greatest praise from all parts of the world.

—L.D.G.

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FOR SALE: Cameras, Eastman Hawkeye Aerial, L type, 4 x 5 plate, 10 inch focal length, complete with lens, all in fitted wooden box with magazines and accessories. Henry K. Fort, Widener Bldg., Philadelphia, Pa.

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An Underslung Sloping Core Radiator;

A Small Body properly arranged;

A Semi-thick Airfoil Section of True Contour throughout the entire length of both the Small Elliptical Lower Wing and the Larger Tapered Upper Wing;

A Single Bay Biplane with external brace wires in Front Truss Only;

An ideal proportioning of Unbalanced Control Surfaces, giving unprecedented ease and range of control.

DESIGNED IN THE YEAR 1922; PRODUCED AND FLOWN EARLY IN THE YEAR 1923

BOEING AIRPLANE COMPANY

SEATTLE, WASHINGTON